

Impact of Elevated Aerosol Layers on Aerosol Optical Depth during TCAP



Pacific Northwest
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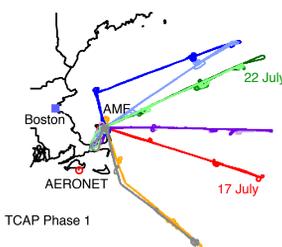
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Goal

Document the impact of elevated aerosol layers on the columnar aerosol optical depth (AOD) during Phase 1 of the Two Column Aerosol Project (TCAP) using data from the AMF and two research aircraft.

Aircraft Flight Patterns

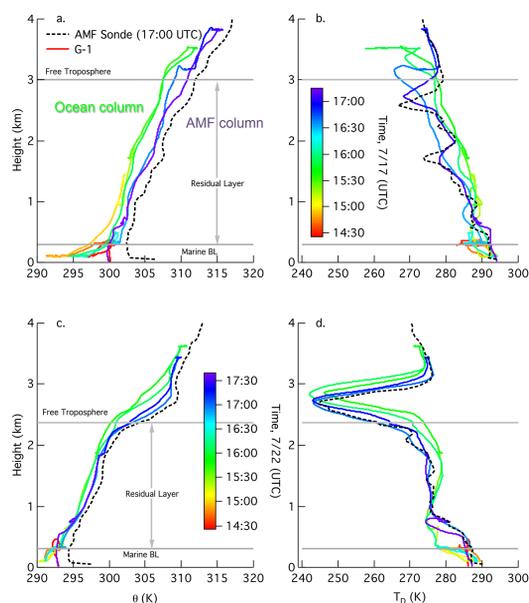
Flight patterns were designed to be very simple and repeatable with close coordination between the DOE G-1 and the NASA Langley King air. This study will focus on two days, one with **large aerosol** loading (17 July) and one with **small aerosol** loading (22 July).



Aircraft flight tracks flown during TCAP Phase 1.

Thermodynamic Structure

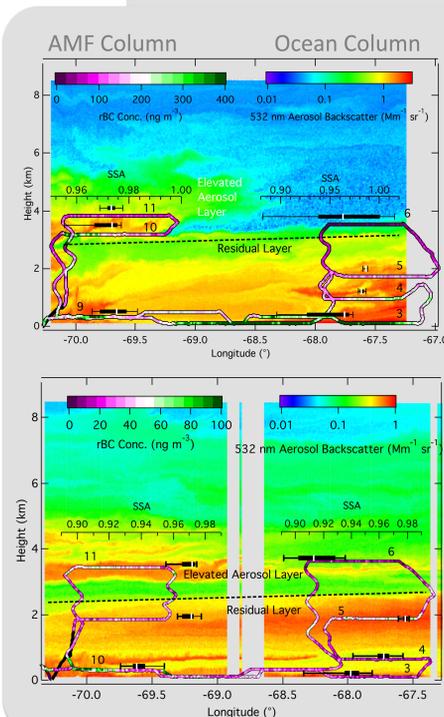
Observations made during TCAP flights indicate the presence of a deep residual layer with a thin internal marine boundary layer.



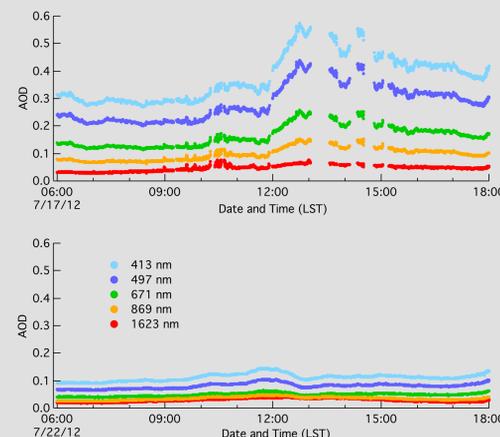
Thermodynamic profiles measured using the G-1 (colors indicate time in UTC) and AMF radiosonde. Gray lines indicate the transition between atmospheric layers.

Aerosol Layers

Aerosol layers above the residual layer were quite common and were observed on four of six flight days. Examples of such layers are shown in the plots of aerosol backscatter measured by the second-generation NASA High Spectral Resolution Lidar (HSRL-2) for 17 and 22 July.



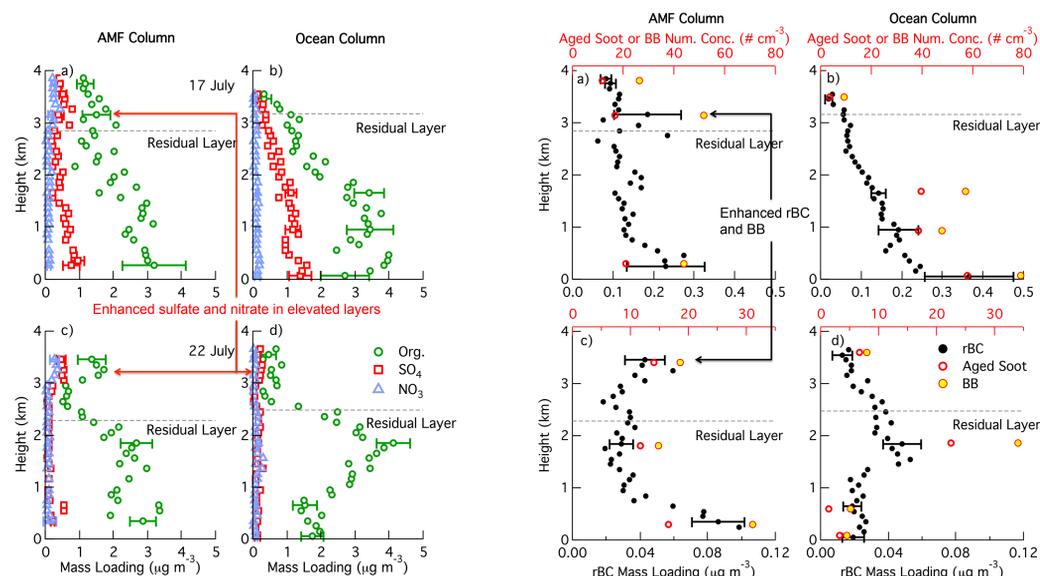
Aerosol backscatter measured by the HSRL-2 (background colors), G-1 flight path [colors indicate amount of refractory Black Carbon (rBC)], and single-scattering albedo (SSA-box and whisker) showing the 95th, 75th, 50th, 25th, and 5th percentile for flight legs indicated by the numbers.



AOD derived from the MFRSR deployed at the surface site for 17 (top) and 22 (bottom) July. Colors indicate the AOD for specific wavelengths.

Chemical Composition

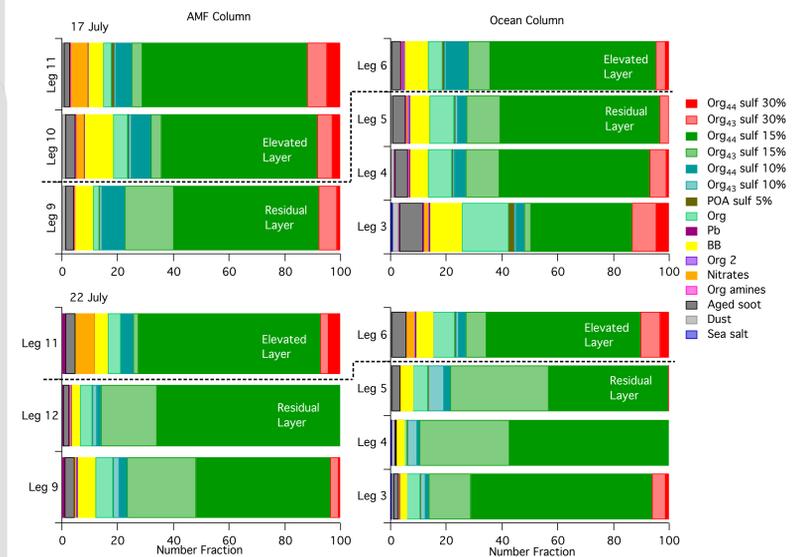
Aerosol chemical composition was measured using an Aerosol Mass Spectrometer (AMS), Single Particle Soot Photometer (SP2), and miniSPLAT single particle mass spectrometer. Elevated aerosol layers had increased amounts of nitrate, rBC, and biomass burning aerosol.



Aerosol mass loadings measured using the AMS (organics, sulfate, and nitrate) and SP2 (rBC), and aerosol number concentration measured using the miniSPLAT (biomass burning, and aged soot).

Aerosol Mixing State

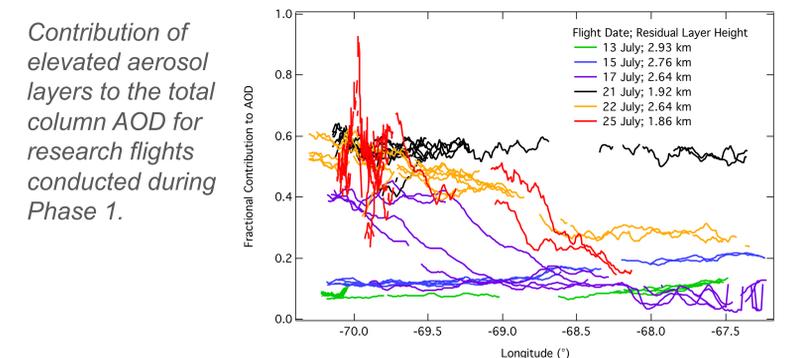
Aerosol chemical composition and mixing state were measured using the miniSPLAT. The majority of aerosol observed during TCAP were organics mixed with varying amounts of sulfate.



Number fraction of different classes of mixtures measured using the miniSPLAT for legs depicted in HSRL-2 plot.

Impact of Elevated Layers on AOD

Aerosol extinction, measured using HSRL-2, was used to determine the contribution of elevated aerosol layers on the total column AOD for all research flights in Phase 1. Elevated layers contributed up to 60% of the total AOD on some days.



Contribution of elevated aerosol layers to the total column AOD for research flights conducted during Phase 1.

Conclusions and Future Efforts

TCAP provides a unique opportunity to investigate the frequency of occurrence, chemical composition, and aerosol optical properties of elevated aerosol layers near the east coast of North America.

- The G-1 and King Air aircraft were able to sample elevated aerosol layers on four of six flight days during Phase 1 of TCAP.
- The aerosol in the elevated layers had enhanced amounts of rBC, biomass burning aerosol, sulfate and nitrate.
- Elevated aerosol layers can contribute up to 60% of the total column optical depth.

The TCAP data set will be used to evaluate regional and global models, including the ability of the models to simulate the radiative impact of the aerosol layers.